

Woolf SH, Kuzel AJ, Dovey SM, Phillips RL. A string of mistakes: the importance of cascade analysis in describing, counting, and preventing medical errors *Ann Fam Med*. 2004;2:317-326.

<http://www.annfammed.org/cgi/content/full/2/4/317/DC1>

Appendix 1. Expanded Study Details

METHODS

Physician Characteristics

The 18 family physicians who filed error reports had been in practice an average of 16 years. Although 18% practiced in the inner city, most practiced in suburban (41%) or rural settings (41%). They filed 75 error reports, with 1 physician filing 27 (36%) reports, 2 posting 6 to 11 reports, 8 filing 2 to 5 reports, and 7 posting 1 report.

Data Collection Instrument

Appendix 1, Table 1 lists the specific questions that physicians answered when posting error reports using an online software template (Healix Software, World Health Network, London, UK).

Definition of Medical Errors Presented to Physicians

The Web site indicated that, "Errors are events in your practice that make you conclude: *'that was a threat to patient well-being and should not happen. I don't want it to happen again.'* Such an event affects or could affect the quality of the care you give your patients. Errors may be large or small, administrative or clinical, or actions taken or not taken. Errors may or may not have discernible effects...."

Comparison of Coding Used In This Study With Results Using the LINNAEUS Taxonomy

In 2001 the international investigators in the LINNAEUS project coded all error reports from the 6 countries, including those subsequently analyzed in our study, according to the LINNAEUS taxonomy.¹ The first tier of the taxonomy consisted of (1) process errors and (2) errors related to gaps in knowledge or skills. The second tier of process errors related to office administration (1.1), investigations (1.2), treatments (1.3), communication (1.4), payment (1.5), and workforce (1.6). The second tier of knowledge and skill deficits included errors in the execution of a clinical task (2.1), wrong diagnosis (2.2), and wrong treatment decision (2.3). The LINNAEUS taxonomy extends to 5 tiers and includes a total of 413 codes. Using the 30 third-tier codes of the LINNAEUS taxonomy, we recoded each of the errors within the 75 incidents reported by the US physicians and compared the results with the 5-domain coding used in our study (see main paper).

RESULTS

Influence of Unit of Analysis and Taxonomy on Distribution of Errors

Appendix 1, Table 2, column A presents the distribution of the 75 incidents by LINNAEUS categories. The distribution suggests that certain errors are most commonly reported, but which category to label as the most common error depends on which tier of the taxonomy is examined: processes of care (first tier), office administration (second tier), or medications (third tier). Appendix 1, Table 2, column B holds the taxonomy constant but alters the unit of analysis, presenting the LINNAEUS distribution not of incidents but of the errors (N = 184) that occurred in the incidents. What emerges as the most common error in the second tier is not office administration but treatment. Appendix 1, Table 3 holds the unit of analysis constant but alters the taxonomy, examining the distribution of the 184 errors across the 5 domains of care (see Methods). Although treatment remains the most commonly reported error type (38% of errors), miscommunication (informational and personal, combined) emerges as equally common (36%).

Composition of Distal Errors

Of the 84 distal errors that occupied the terminus of the 75 incidents, 57 (68%) were treatment errors, 13 (15%) were errors in diagnosis, and 14% were errors in communication. Examples of treatment and diagnostic errors are listed in Appendix 1, Table 3. The 61 distal errors in the 58 incidents that involved cascades included errors in treatment (45, 74%), diagnosis (11, 18%), or communication (5, 8%).

Errors in Communication

The physicians reported 64 errors in communication, 57 involving informational communication, and 7 involving personal communication (Appendix 1, Table 4).

Composition of Proximal Errors

The physicians reported 9 incidents that began with mistakes in diagnosis and 18 that began with treatment errors (Appendix 1, Table 5).

Consequences to Patients

The physicians described 35 (32 observed, 3 presumed) health consequences in 30 narratives. Investigator analysis of the narratives identified 67 additional ways in which the health of patients was necessarily (9) or likely (58) affected but went unmentioned by the physicians, and 30 incidents in which opportunity costs were likely (Appendix 1, Table 6).

DISCUSSION

Reason's classic model of organizational accidents (Appendix 1, Figure 1) recognized that errors (unsafe acts) are active failures that arise from error-producing environmental conditions, and that these conditions arise from flawed organizational systems (latent failures).

Reference

1. Dovey SM, Meyers DS, Phillips RL, Green LA, Fryer GE, Galliher J, Kappus J. A Preliminary Taxonomy of Medical Errors in Family Practice. *Qual Safety Hlth Care* 2002; 11: 233-238.

Appendix 1, Table 1. Information Collected From Physicians When Filing Online Error Reports

Field	Response Format
Country	Country code
Personal identifier	Unique identifier nominated by each study participant
Date report submitted	Date
Is error related to a patient?	Yes or no
(if YES) How well do you know the patient?	1 = I have never seen the patient before and I am not familiar with his/her health problems 2 = I have seen the patient before but I am not familiar with his/her health problems 3 = I am somewhat familiar with the patient and his/her health problems 4 = I am fairly familiar with the patient and know his/her health problems quite well 5 = I am very familiar with the patient and his/her health problems
(if YES) Patient's age	In years
(if YES) Patient's sex	Male or female
(if YES) Is patient a member of an ethnic minority group?	Yes or no
Does patient have a complex health problem?	Yes or no
Does patient have a chronic health problem?	Yes or no
What happened?	Free text to explain what happened
What was the result?	Free text to present the reporter's views about the error's consequences
Contributing factors	Free text to explain other circumstances surrounding the error
What could have prevented it?	Free text to provide reporter's views on preventive strategies
Where did this error occur?	Your office or surgery, laboratory, radiology, pharmacy, emergency room, hospital, nursing home, patient's home, telephone contact, other (more than 1 location could be selected)
Was any patient harmed?	Yes or no
(if YES) Seriousness of this harm?	1 = Not very serious 2 = Somewhat serious 3 = Serious 4 = Very serious 5 = Extremely serious
How often do you see this error?	1 = This is the first time it has occurred 2 = Seldom (1-2/y) 3 = Sometimes (3-11/y) 4 = Frequently (≥ 1/mo)

Appendix 1, Table 2. Distributions of Incidents (n = 75) vs Component Errors Within Cascades (n = 184) by LINNAEUS Taxonomy

Incidents and Component Errors			LINNAEUS Categories	
			A Incidents No. (%)	B Errors No. (%)
First Tier	Second Tier	Third Tier		
Process errors			62 (83)	135 (73)
	Treatment errors		15 (20)	50 (27)
		Medications	11 (15)	38 (21)
		Other treatments	4 (5)	12 (7)
	Office administration		21 (28)	33 (18)
		Chart completeness	9 (12)	12 (7)
		Message handling	5 (7)	7 (4)
		Filing system	4 (5)	9 (5)
		Patient flow	1 (1)	3 (2)
		Appointments	2 (3)	2 (1)
	Investigations		12 (16)	27 (15)
		Laboratory	10 (13)	20 (11)
		Diagnostic imaging	2 (3)	6 (3)
		Other investigations	0 (0)	1 (0)
	Communication		12 (16)	23 (13)
		With patients	7 (9)	13 (7)
		With nonphysicians	2 (3)	4 (2)
		With other physicians	1 (1)	1 (0)
		Between the whole team	2 (3)	5 (3)
	Payment (insurance-related errors)		2 (3)	2 (1)
Knowledge or skills errors			13 (17)	49 (27)
	Execution of a clinical task		2 (3)	6 (3)
	Wrong diagnosis		7 (9)	26 (14)
	Wrong treatment decision		4 (5)	17 (9)

Note: see text and Dovey et al¹ for description of LINNAEUS taxonomy and tiers.

Appendix 1, Table 3. Composition of Distal Treatment and Diagnostic Errors

Error Category	Number
Treatment errors	
Delays in care (eg, taking too long to begin or adjust treatments)	24
Prescribing the wrong drug	9
Prescribing the wrong dose	7
Omissions in care	9
Interrupted care (eg, not refilling medications)	4
Inadequate treatment (eg, not achieving glycemic control)	2
Unnecessary care	2
Total treatment errors	57
Diagnostic errors	
Delays in screening or diagnosis (eg, delay in evaluating jaundice)	9
Unnecessary testing (eg, extra blood work caused by a proximal error)	3
Omissions (eg, failure to perform screening)	1
Total diagnostic errors	13

Appendix 1, Table 4. Errors in Communication Reported by Physicians, N = 64

Errors in informational communication (n = 57)

Miscommunication among colleagues (n = 20)

- From outside facilities (n = 8)
 - Physical therapist's concerns not communicated to physician
 - Failure to transfer treatment plan to primary care provider
 - Failure to notify physician of abnormal laboratory test result
 - Nursing failure to notify physician of abnormal laboratory results
 - Delay of nursing home staff in alerting physician about patient's refusal of medication
 - Delay of radiology facility in reporting results to physician
 - X-ray film not available for interpretation by ordering physician
 - Consultant-requested monitoring not documented in chart
- With laboratory (n = 5)
 - Nurse ordered wrong test
 - Laboratory performed test other than that ordered by physician (n = 4)
- With pharmacist (n = 4)
 - Prescription incorrectly written—no signature
 - Physician prescription not followed by pharmacy
 - Physician verbal order misunderstood by pharmacist
 - Incorrect medication called in for patient
- To caretakers (n = 3)
 - Physician order for medication not followed (n = 2)
 - Insulin orders not followed

Miscommunication between physician and patient (n = 5)

- Could not contact patient to fix problem
- Delay in patient's receipt of results
- Patients given inaccurate test results
- Laboratory results sent to wrong patient
- Breach of patient confidentiality

Misinformation in medical records (n = 12)

- Incorrect chart number entered in computer system
- Patient identities confused
- Nurse failed to check unique patient identifiers in database
- Laboratory results matched to wrong patient (same name)
- Physical examination data entry error
- Incorrect notation of medical history
- Wrong medical history on mammogram report
- Wrong values on laboratory report
- Specimen (Papanicolaou slide) not labeled with patient name
- Information in paper and computer records did not match
- Wrong patient's laboratory data attached to result form letter
- Use of misleading flow sheet

Flawed message handling (n = 10)

- Lack of ongoing system for triaging importance of messages
- Inadequate triage of incoming message
- Delay in responding to patient telephone calls
- Patient request for medication not acted on
- Medication refill request not given to the physician
- Message to triage nurse obscured by other papers
- Failure to attend to pending request for action
- Message from pregnant patient with problem not given to provider able to respond
- Available provider not made aware of patient's concern
- Abnormal laboratory result filed without physician action

Inaccessibility to medical record (n = 7)

- Chart not available when needed
- Failure to provide for access to charts when practice closed
- Patients' previous records not available to next physician
- Chart lost
- Chart with refill request not available
- Incomplete medication history available to prescriber
- Pertinent patient information not available to covering physician

Lack of reminder system (n = 3)

- Failure to respond to missed appointment
- Failure to respond to laboratory evidence of diabetes
- Physician instructions to patient to return for INR testing not followed

Errors in personal communication (n = 7)

With patient (n = 6)

- Failure to negotiate patient acceptance of treatment plan (n = 3)
- Patient not made aware that she should call for prescription after finishing samples
- Incorrect follow-up instructions
- Failure to instruct patient on bowel preparation for colonoscopy

With professionals (n = 1)

- X-ray facility did not follow physician instructions to return patient and films

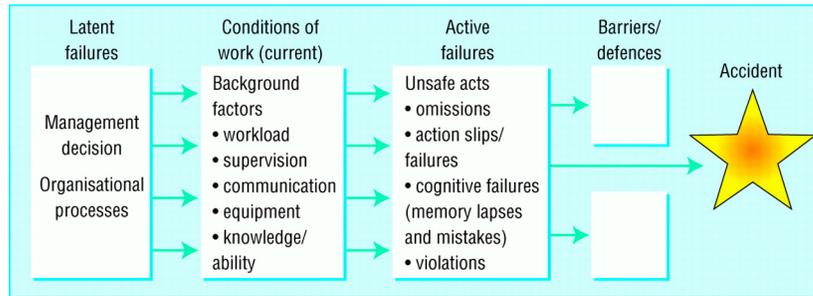
Appendix 1, Table 5. Errors Set Off by an Initial (Proximal) Error in Diagnosis or Treatment

Proximal Diagnostic Errors (n = 9)	Proximal Treatment Errors (n = 18)
<p>Omitted examination Misdiagnosis of cellulitis Misdiagnosis of acute otitis media as acute otitis externa Missed diagnosis of Rocky Mountain spotted fever Failure to diagnose accurately cause of cognitive changes Failure to recognize alcohol withdrawal Fracture missed on x-ray examination No timely plan for follow-up of urgent laboratory test Laboratory performed direct instead of total bilirubin assay</p>	<p>Patient not seen for hypotension Inappropriate drug therapy for hypertension Unnecessary treatment of premature ventricular contractions Failure to appropriately treat atrial fibrillation Not assessing for allergy to medication Failure to account for risk of fall in hospital* Wrong dose of estradiol cypionate prescribed Wrong dose of antibiotic ordered† Inadequate dose of antibiotic prescribed for resistant acute otitis media† Wrong medication with similar name prescribed† Wrong medication schedule prescribed Improper dosing frequency of methotrexate Pharmacy dispensed wrong medication† Nurse gave diluent instead of diluent plus vaccine Failure to execute plan for immunization Failure to continue assist device (walker) in hospital* Failure to remove heparin lock† Treating patient with whom physician had close personal relationship</p>
<p>* Dual-error incident, no cascade. † One-error incident, no cascade.</p>	

Appendix 1, Table 6. Observed and Presumed Consequences to Patients

Consequence	No.	Examples of Consequences, Observed or Presumed
Increased health risk for future physical harm		
Observed*		
Doctor	11	From poorly controlled hypertension, diabetes; inadequate anticoagulation; untreated fracture
Investigator	1	From inadequate malaria prophylaxis
Presumed*		
Doctor	2	For thromboembolic event or delayed detection of cancer
Investigator	8	From inadequate treatment of <i>Trichomonas vaginalis</i> infection and tuberculosis prophylaxis, poor blood pressure and glycemic control, interrupted prenatal care
Total	22	
Physical harm		
Observed		
Doctor	15	Epidural hematoma, hip fracture, neonatal brain injury, symptoms of Rocky Mountain spotted fever, volume depletion, dyspnea, drug eruption, confusion, drug dependence, peripheral dysesthesia
Investigator	7	Discomfort of unnecessary venipuncture, heel stick, pelvic examination; unnecessary preparation and intubation for surgery; prolonged orthostasis and cellulitis
Presumed		
Doctor	1	Exacerbation of otitis media and need for parenteral antibiotics
Investigator	5	Increased pain from fracture, otitis media; untreated alcohol withdrawal symptoms
Total	28	
Emotional or psychological harm		
Observed		
Doctor	6	Frustration, anger, erosion of confidence
Investigator	1	Confusion over medical advice
Presumed		
Doctor	0	None identified
Investigator	45	Frustration, erosion in trust, confusion, prolonged or unnecessary anxiety or worry, anger, resentment, dissatisfaction
Total	52	
Opportunity costs	30	Out-of-pocket costs; time and travel for extra office visits and hospital days; inconvenience caused by delays and need for telephone calls, repeat visits and testing, unnecessary treatments
*Observed = consequence reported or self-evident in narrative; presumed = considered likely.		

Figure 1. Organizational accident model based on Reason.



From: Reason JT. Understanding adverse events: human factors. In: Vincent CA, ed. *Clinical Risk Management*. London: BMJ Publications, 1995:31-54. Reprinted with permission from: Vincent C, Taylor-Adams S, Stanhope N. *Br Med J*. 1998;316:1154-1157